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*Edgar S. Sargent*

# Respiration in Health and Disease.

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## RESPIRATION IN HEALTH AND DISEASE.

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GENTLEMEN,—Within recent times so much new evidence has accumulated with reference to the important function of respiration, that, unless one has carefully noted step by step the various advances in our knowledge of this subject, one is apt to be a little uncertain as to the position that has already been attained. It is in the hope that I may be able to lay before you certain points which are likely to be of frequent service in the daily practice of our profession that I have chosen one aspect only of this vast subject as worthy of our attention to-day.

Leaving aside entirely the chemical changes which occur, and the prevailing influence of the nervous system, I propose to deal only with the mechanisms involved. My theme, therefore, falls naturally into two main divisions:—

I. Respiration and its Maintenance in Health.

II. Respiration and its Treatment in Disease.

I have no desire to enter upon a long physiological disquisition on the various issues which present themselves, but will content myself with briefly outlining the order of events which occurs during the respiratory cycle, since in dealing with an individual patient, unless one has a sufficient knowledge of what constitutes the standard in health, and exactly how the patient has deviated from this standard, directions for treatment will lack that precision which is requisite for success.

I. Let us first consider the mechanism of respiration in health. From the practical point of view, perhaps the simplest way is to start at the beginning from broad general principles, and from the general, proceed to evolve the particular. On this basis the mechanism of respiration should be regarded as influencing, and in turn being influenced by the whole structure of the organism. Any variation in the contour of the trunk produced by muscular action, or any change in size of the body-cavity, causes a definite and corresponding effect upon respiration. All the other systems also influence in some degree the character of the respiratory movements.

The clearest idea of the mechanism of respiration is probably gained by regarding man from the com-



parative standpoint, and his abdominal and thoracic cavities as together constituting one great cavity, the diaphragm being considered as a structure subsequently introduced, first, in order to aid the flow of blood, and, secondly, to play its part as a respiratory muscle. On reviewing this aspect we see that the influence of respiration is continuous throughout the body-cavity, the whole of the contents being acted upon by the movements of breathing, and the regional effects of these being manifest from neck above to perinæum below.

It is impossible to dissociate the action of the diaphragm from that of the other thoracic, spinal and abdominal muscles, since its mediate position causes it to share in their action, and thereby to show how the movements of each great group are correlated. The abdominal muscles must be studied just as much as those of the thorax, which have up till now engrossed too large a share of attention, and these in turn, together with those of the vertebral column. Respiration is not solely a thoracic act; each time we breathe quietly our abdominal muscles are called into play equally with our thoracic muscles, and in deep breathing this is still more evident.

Will you allow me for a few moments to discuss the chief so-called "types of respiration," and to tell you why I regard these as defective?

The teaching of those who advocate "chest breathing," "abdominal breathing," "back breathing," or any of the other terms which are in constant use is in my judgment unsound, inasmuch as these teachers are setting up a part in place of the whole, and thereby considerable advantage must of necessity be lost in the maintenance of sustained effort.

(a) *Clavicular Breathing*.—In this form of breathing the clavicles and scapulæ, which, together with their ligaments, constitute the pectoral girdle, are actively raised along with the upper part of the chest. Considerable waste of energy occurs, firstly, because the muscles of the shoulder-girdle, which are muscles of extraordinary respiration only, are brought into unnecessary activity, and, secondly, because only a very small portion of the respiratory mechanism is brought into play. In the use of the voice for any length of time the employment of this method produces hoarseness and fatigue.

(b) *Superior Costal Breathing*.—In this form the upper part of the chest is expanded disproportionately to the remainder with raising of the clavicles (v. Fig. 7, Orthodiagram No. III.). This method of itself is insufficient although quite good as far as it goes. Since in this case, however, the

movement is limited to the upper part of the chest, where all its diameters are smallest, this fact alone contra-indicates the general use of this mode, except, indeed, in combination with the two movements which precede it in the true inspiratory cycle.

(c) *Inferior Costal (so-called "lateral costal") Breathing*.—In this method according to various views which are held the abdominal wall either is drawn in by contraction of the abdominal muscles, or else is kept "rigid in its lower  $\frac{2}{3}$ !" The lower portion of the chest is thus enlarged mainly from side to side. This is the method advocated to the exclusion of all others by the majority of singing masters of the present day. I have no hesitation in condemning this method taken by itself as insufficient for the production of full effective and sustained tone in singing, and as medical men we see this form of respiration in frequent association with diseased conditions of the chest, especially in pulmonary tuberculosis, where the apices of the lungs are affected and flattening of the upper chest along with diminished movement occurs.

(d) *Abdominal Breathing*.—The lower ribs are fixed and the abdomen protruded in excess of the normal. For this to happen relaxation of the abdominal walls is needed; hence this form is always pathological, leading as it does to compression of the abdominopelvic contents with resultant herniæ, dyspepsias and other maladies.

Having touched lightly on these topics, I will now pass on to the results which we obtain from experimental observation.

During the past ten years changes in size and position of the thoracic contents have been studied by means of watching their moving shadows on the fluorescent screen. Owing, however, to the fact that the rays proceeding from an X-ray tube are divergent, and so produce magnification of the shadow of the object under investigation, in order to obtain greater exactitude, in 1907, with Dr. Hugh Walsham, I began a series of experiments with the orthodiagraph, (1) a method of investigation then new to this country. By means of this instrument, it is possible with almost mathematical accuracy to measure motionless objects which lie in a plane parallel with the transverse plane of the body, and to measure moving objects with greater accuracy than can be attained in any other manner than by instantaneous radiography. (Some of the results obtained by orthodiagraphic measurement of physiological changes in the trunk are well shown in Fig. 1, orthodiagram No. I.) In full inspiration the neck is shortened and widened; the shoulders are



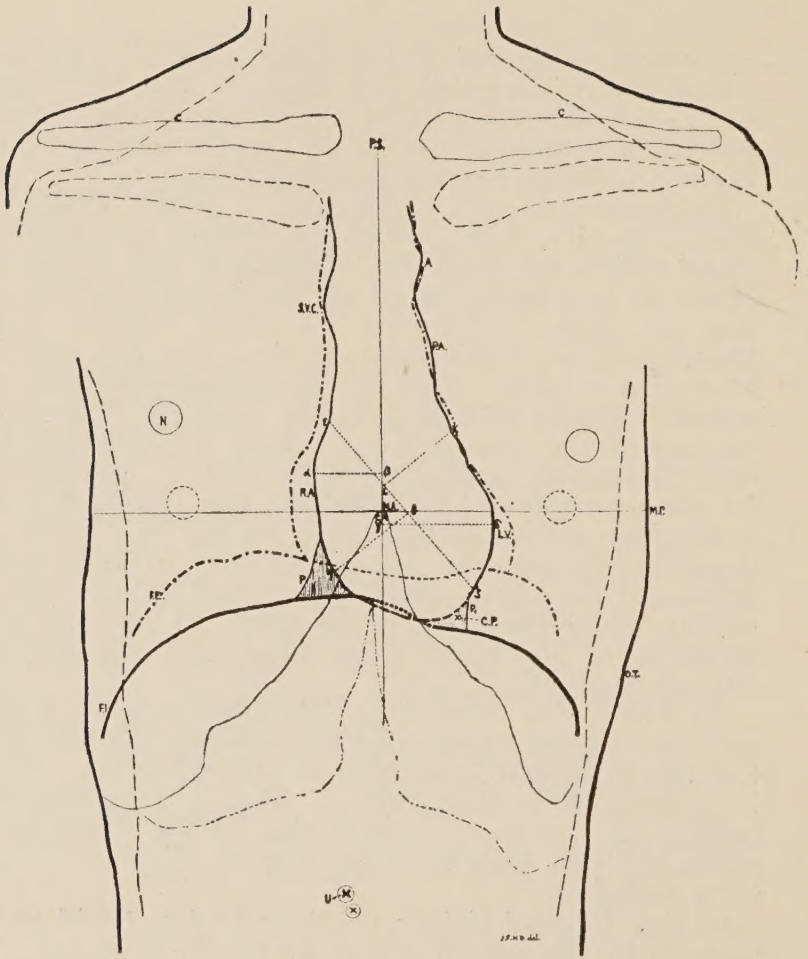


FIG. I.—ORTHODIAGRAM No. I.

C=mid-clavicular point. PS=pre-sternal notch. SVC=superior vena cava. RA=right auricle. A=aortic arch and first portion of descending aorta. PA=left pulmonary artery. LV=left ventricle. P=pericardium + plicæ adiposæ. PI=pericardium.  $\alpha\beta$ =diameter of right auricle.  $\gamma\delta$ =diameter of left ventricle.  $\epsilon\xi$ =longitudinal diameter of heart.  $\eta\theta + \iota\kappa$ =diameter of right ventricle. N=nipple. U=umbilicus. FE=forced expiration (position of diaphragm in). NE=normal expiration (position of diaphragm in). NI=normal inspiration (position of diaphragm in). FI=forced inspiration (position of diaphragm in). MA=meso-metasternal articulation. MP=meso-metasternal plane. OT=outline of trunk. CA=infra-costal angle. CP=cardio-phrenic space (for description of which v. the *Lancet*, June 27th, 1903, p. 1802).





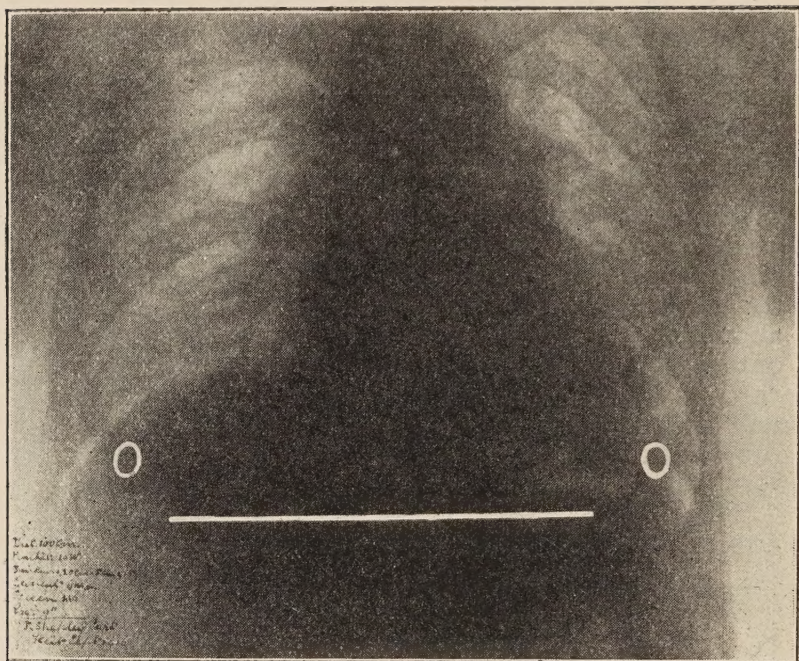


FIG. 3.—RADIOGRAM NO. 2.

position of each nipple, whilst the horizontal wire marks the level of the sterno-xiphoid articulation, the radiant point being on the same meso-metasternal plane. Radiograph No. 1 shows the position of the viscera in deepest possible inspiration; No. 2, in deepest possible expiration. The subject has been trained to breathe efficiently, so that the following points are particularly evident:—(1) The lengthening and narrowing of the heart and pericardium in inspiration, coincidently with the marked excursion of the diaphragm, which is eight centimetres (over three inches); (2) the diaphragm is highly arched, and descends after the fashion of a piston, with no flattening whatever; (3) the ribs in inspiration are raised and separated from one another; (4) in inspiration the lung is full of air, and so is notably transradiant, whilst in expiration the lung is much deflated, and therefore much less transradiant, the evidence of this being seen in the relative contrast between the ribs and their interspaces. Fig. 4, Orthodiagram No. II., taken in the right antero-posterior oblique diameter—*i.e.*, looking through the subject from right nipple to left scapula—shows clearly the anterior and posterior clear spaces in front and behind the heart shadow respectively, which become almost obliterated in expiration through the lung being deflated and the transradiancy consequently much diminished.



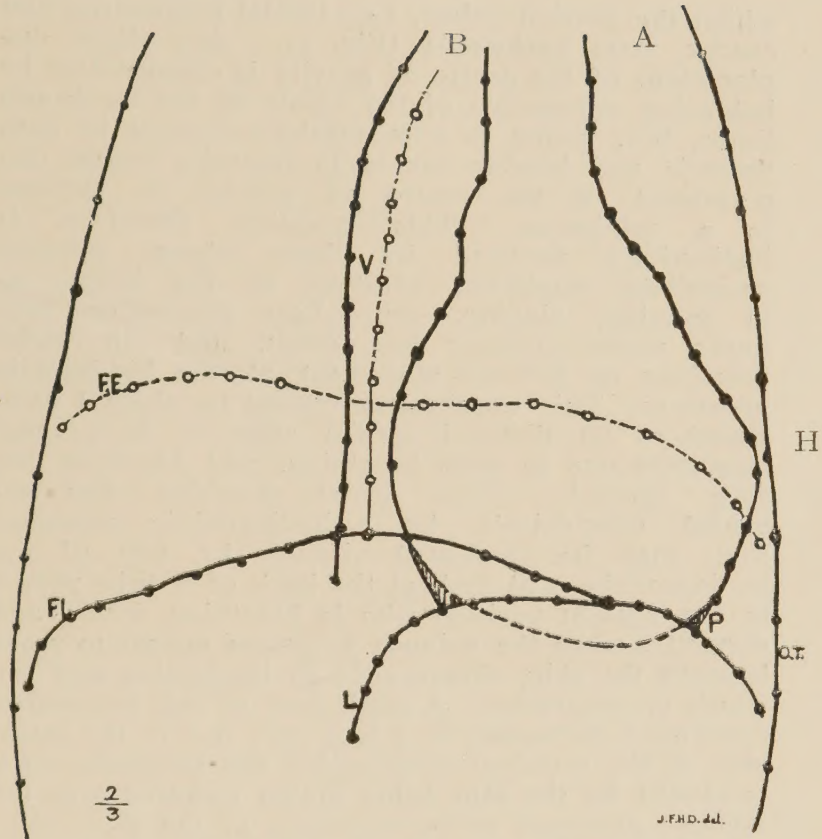


FIG. 4.—ORTHODIAGRAM No. II.

In right antero-posterior oblique diameter shows the movement of the diaphragm between full inspiration (F.I.) and expiration (F.E.), the range of the vertebral column (V.), the contour of the liver (L.), and of the heart (H.), with the anterior cardiac space (A.) and the posterior cardiac space (B.).

There are three points which I wish to bring especially before your notice:—

(1) The movement of the vertebral column in respiration.

(2) The movement of the abdominal muscles in respiration.

(3) The movement of the diaphragm column in respiration.

(1) *Movement of the Vertebral Column in Respiration.*  
—As the thoracic spinal curve is opened out (extended) in deep inspiration, compensatory increase of the lumbar forward curvature takes place with rotation of the pelvis around a horizontal transverse axis passing through the centre of the hip-joints, in such wise as to bring the portion above this axis to the front,

whilst the portion below, *i.e.*, ischial tuberosities and coccyx, pass backwards (Fig. 5). Any slight displacement of the centre of gravity is compensated by balancing movements of the whole of the trunk and limbs, but, owing to compensatory changes in both thoracic and lumbar curves in opposite senses, displacement of the centre of gravity is reduced to a minimum. This position, therefore, is instinctively assumed by those whose pursuits necessitate maximum aëration of the lungs, as in running, singing, etc. Less respiration produces correspondingly less effect, and in quiet breathing no forward movement at the hip-joint is necessary. This vertebral movement to which I have elsewhere (2) directed special attention is a most important one in deep breathing, and has been too long ignored. This spinal extension first revealed conclusively by orthodiagraphic examination, may be confirmed visually by any of my audience who will look at the back of a thin person in the upright position who is breathing deeply and correctly, when the spinous processes appear to move beneath the skin, downwards on inspiration and upwards on expiration. A small part of this inspiratory downward movement is a true one, due to the extension of the vertebral column, but the remainder of it is caused by the skin being drawn upwards over the spinous processes owing to raising of the shoulders.

(2) *Movement of the Abdominal Muscles in Respiration.*

—Ordinary as well as forced expiration, as a whole, is a process compounded of active muscular contraction and passive elastic recoil of both muscle and viscera. Expiration consists in a combination of muscular action with visceral recoil. The anterior abdominal muscles push back the intra-abdominal viscera, this action being aided by the potential energy accumulated through inspiratory change of position of thoracic and abdominal viscera, which, when the diaphragmatic compression is released, by reason of their inherent elasticity, tend to return to their former state, and so to raise the relaxed diaphragm. Just as in other parts, direct interaction occurs between opposing groups of muscles, the one group being unable to contract without corresponding relaxation on the part of its opponents, so in expiration the abdominal muscles are the direct antagonists of the diaphragm, and in inspiration the abdominal muscles are passive. The diaphragm can only contract when these are inhibited: when the abdominal muscles contract the diaphragm is inhibited. Similar antagonism takes place between the inspiratory and expiratory sets of thoracic muscles.



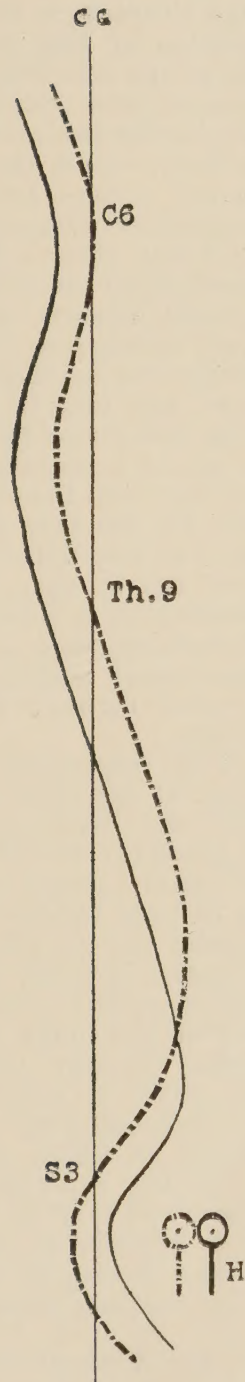


FIG. 5. (diagrammatic), showing extension of the vertebral column during inspiration. Continuous line=inspiration. Broken line=expiration. C6=sixth cervical vertebra. Th9=ninth thoracic vertebra. S3=third sacral vertebra. CG=centre of gravity. H=hip-joint.

(3) *Movement of the Diaphragm in Respiration.*—For any adequate description of this movement you will in vain consult most of the standard works on physiology. Until the present date most of these works state that during inspiration the central tendon of the diaphragm remains fixed, whilst the domes flatten in descent, this supposed action being illustrated in many cases by imaginative diagrams. In point of fact no such action takes place. It is true that on orthodiagraphic examination in subjects with well-developed diaphragmatic descent a slight depression is sometimes seen just external to the summit of the right dome, this being due to the strong downward pull of the right crus, and that in some people with marked raising of the lower ribs the convexity of the dome represents the arc of a slightly larger circle than it does in expiration, but with these minor exceptions, which I only mention for the sake of completeness, it is incorrect to state that any flattening of the domes occurs. As I pointed out in 1903, (3) "the curve of the convexity on each side is unaltered in descent, and each half—although attached to its fellow of the opposite side by the central tendon—by means of its own separate innervation through the phrenic nerve, acts quite independently."

The first portion of an inspiratory movement is performed by contraction of the short and weak ventral or sternal fibres of the diaphragm simultaneously with the long and powerful dorsal or crural fibres. The two pillars or crura, arising by a firm origin from the first three or four lumbar vertebræ, exert a strong pull downwards and forwards upon the posterior part of the central tendon, and through this upon all the structures of the mediastinum, particularly the heart, root of the lungs and great vessels. These structures, when viewed laterally, occupy a triangle the base of which is formed by the central tendon, the anterior boundary by the sternum, and the posterior boundary, to which the roots of the lungs are attached, by the superior vena cava, auricular base of the heart, and inferior vena cava. "The apex of the triangle is attached to the upper aperture of the thorax. When a breath is taken the mediastinal triangle and its contents swing forwards from the spine." (4)

*The Mechanism of the Natural Complete Breath.*—Following expiration, there occurs a slight passive protrusion of the anterior abdominal wall—Fig. 6 (1). This corresponds to the initial active contraction of the crura and sternal fibres of the diaphragm, which constitutes, as I have just said, the first act in inspiration. Next following



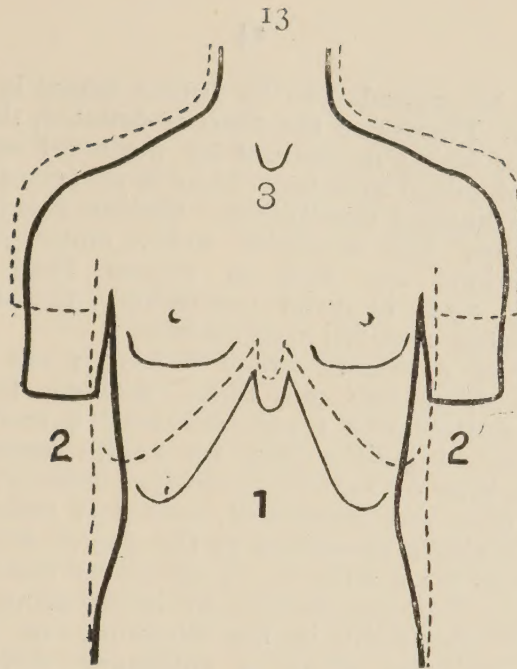


FIG. 6 (diagrammatic).

Showing alteration in contour of trunk during inspiration (broken line), and expiration (continuous line).

in even and orderly sequence comes a raising of the lower or diaphragmatic set of ribs—Fig. 6 (2)—together with backward expansion of the chest over the area corresponding to the lower lobes, the lateral movement being the more marked of the two. This second movement is also caused by the diaphragm, which, having by this time descended until its central tendon exerts firm continuous pressure upon the intra-abdominal viscera, now executes the second part of its dual action in contracting its ring of costal fibres. These, being attached at an oblique angle to the ribs in contraction, raise the ribs upwards and outwards, being aided by the external intercostals and intercartilaginous portions of the internal intercostals. In addition to rotation upwards there is also a posterior movement of these ribs at the latter end of the action. The third and last movement consists in full inflation of the part of the chest corresponding to the upper or costal set of ribs caused by the raising of these by the external intercostals and intercartilaginei, accompanied by an extension of the thoracic curvature, together with a slight backward swing of the thoracic spine as a whole.

The whole of these acts, which in complete breathing glide into one another, constitute what I have termed “the complete cycle of full inflation.” At the end of this series of movements the chest will be

found to be expanded to its fullest extent in all three diameters. Thereupon the chest is deflated, the supplemental air being driven out by powerful contraction of the abdominal muscles. Thus is performed the full cycle of complete respiration. Ordinary quiet breathing requires less muscular work, consequently the manifestations are less in degree than in deep breathing, and in quiet respiration the diaphragm takes a large proportionate share.

From the evidences which I have given above in this lecture, as well as those derived from other sources, particularly from comparative anatomy and morphology, I believe that for health there is only one main type of natural breathing—namely, the type which I have just mentioned, and that under various conditions slight variations in the degree and even in the order of the events which constitute the cycle may obtain, but that any marked deviation either in order or degree, especially in the direction of omission, usually indicates either a voluntary deviation for some special purpose or a pathological state. Hence the so-called types—clavicular, abdominal, and other such irregularities are on this view instances of imperfect, insufficient or diseased conditions. It is a deplorable fact that much incalculable harm has been and is being done by the erroneous instruction of teachers of singing, who, for the most part, are totally devoid of any accurate knowledge of the physiology of voice-production.

In the variations which occur, sex has a definite influence, the diaphragm and abdominal muscles being used to a larger extent in males than in females under conditions of civilisation. Age changes also bring about variation, the diaphragm being less functionally active with advancing years. Idiosyncrasy, habit, will-power, or suggestion, and any emotion or even sudden change of thought, may cause variation in the order of respiratory events, but all these should in reality be regarded as exceptions to the prevailing rule.

Having dealt with the mechanism of physiological breathing, next I come to the manner in which this may best be taught in the form of exercises. The following points should receive attention:—

(a) *Removal of Causes which Obstruct Free Air-entry.*—With these I will deal more fully in the second part of my lecture.

(b) *Preliminary Exercises.*—Thoracic mobility is of far greater importance than mere size of chest, so that, in order to secure maximum flexibility of the trunk as a whole, on each occasion before breathing



is actually begun I would strongly urge the adoption of stretching, bending and lifting exercises for the trunk, together with exercises of complete muscular relaxation, the latter series necessitating trained assistance, and the whole of the exercises at the outset to be performed under direct supervision of the physician.

The stretching exercises are performed standing naturally, with the feet a few inches apart, the toes being pointed a little outwards. The hands are allowed to hang by the side in an easy, natural position. The trunk is then slowly bent as far as possible first to one side and then to the other. This exercise has the effect of widening the intercostal spaces and of making the whole of the trunk more flexible. The bending exercises consist in placing the hands on the hips with the thumbs in front, first bending forward as far as possible, keeping the spine straight, and next bending slowly backwards. When breathing is learnt these can be supplemented by inspiration during the first half of the movement, and expiration during the latter half, the breath being held at the point of maximum bending or stretching, which is maintained for a few seconds.

The lifting exercises take place with the patient sitting astride. The operator stands behind and gives support to the back of the subject, at the same time placing his hands in the axillæ. The operator lifts the chest while the patient inspires slowly, and breathes out whilst the chest is lowered. This exercise is very useful for those with weak muscles.

*Breathing Exercises.*—The first and most important of these is the natural complete breath. When this is thoroughly mastered, and not until then, resistance breathing exercises may be employed by closing one or other nostril. A further exercise consists in expanding each lung separately. Subsequently various movements, either passive or active, may be performed in combination with breathing for different purposes. Each individual exercise would take me far too long to detail, but I shall be happy to demonstrate these exercises and their practical results upon subjects who for some years have been trained according to these principles to any member of my audience who would like to see them.

#### RESPIRATION IN DISEASE AND ITS TREATMENT.

Treatment may be either prophylactic, ameliorative, or curative. I will take prophylaxis first as being the most important.

In theory I suppose that the medical profession as

a whole readily admits the vast importance of correct physiological breathing in the treatment of disease, but in practice this is often far otherwise. If we are successfully to impress upon our patients the fundamental importance of right breathing, we must be prepared both by personal example as well as by precept to show to them what we really mean, and, if necessary, to convince them by direct proof.

Under ordinary conditions only about one-seventh or less of the total lung area becomes expanded, and I need hardly remind you that if this expansion becomes still further lessened this fact alone will account for the prevalence of certain diseases. Full and deep breathing is a perfectly natural phenomenon; diminished breathing results from an artificial and sedentary existence.

In order to breathe correctly, the entire mechanism of respiration must be used, and not a part only. The plaster cast of an adult male and photographs of a boy, æt. 13, show equally well pathological carrying forward of the head and neck, together with upper thoracic kyphosis, flat chest, and prominent abdomen so characteristic of the pure abdominal breather. Medical men, therefore, should, when advising their patients, look to it that the three diameters of the chest are expanded fully, inasmuch as many people imagine that they are taking a complete breath when they are only partially expanding the chest.

Let us begin at the beginning with the new-born infant. An infant needs as plentiful a supply of pure air as does the mother, so that both lying-in room, day and night nurseries should have a proper supply of fresh air with avoidance of draughts. No child is too young to be taught correct breathing, for bad habits of breathing are as easily acquired as bad habits of walking, and, when acquired, are often difficult to overcome. Hence the artificial teat or baby-comforter should be rigidly forbidden, since, in addition to its well-known danger of introducing infective substances into the mouth, it also possesses the injurious property of altering the shape of the hard palate and jaws, and so of causing the infant to keep the mouth open instead of shut. The habit of nose breathing should be enforced from birth, and whenever the mouth of the child is found open during sleep, the lips should be closed by gently pushing upwards the lower jaw. The fine-meshed and heavy veils worn out-of-doors by so many infants, especially when tightly wrapped round the face or pressing upon the nose, promote mouth breathing and prevent access of pure air. Sometimes, too, I have seen garments tied so tightly round the poor baby's



neck, or constricting the chest, in such a manner as to cause congestion of the face and deficient air-entry into the lungs. On both these points I should like to lay special emphasis, as well as on the over-clothing of infants, since most pernicious effects are produced not only upon respiration in particular but upon metabolism in general. Nevertheless, I am fully aware how difficult it is to overcome popular prejudice.

Sun and air baths are greatly beneficial, and after the warm bath strong respirations should be induced by judicious application of cold water, followed by vigorous friction with a towel from the extremities towards the trunk. Thus will the child grow up hardy, and as development further proceeds, open-air games and exercises will add to the effect of these measures by stimulating respiratory interchange through muscular effort. The school, as well as the house, should be scrupulously clean and continuously ventilated.

*Dress and Respiratory Disease.*—(a) *Corsets.*—Badly made and ill-fitting corsets, especially if tightly laced, considerably diminish the respiratory capacity, and upset the balance of forces which obtains in the true respiratory cycle by putting out of action the diaphragmatic lobes of the lungs. The ribs from the sixth downwards are compressed, and their lower edges being crowded together cannot separate during inspiration to any effective extent, hence that portion of the thorax which should be the widest is constricted until it becomes the narrowest. Fig. 7, Orthodiagram No. III. of the chest of a girl, æt. 18, shows this and the following points. The diaphragm descends imperfectly, and is unable to raise the lower set of ribs to which its costal fibres are attached against the circular compression exercised from without. The expansion of the lower lobes being thus interrupted, the upper lobes are disproportionately expanded by excessive raising of the thoracic "lid." On account of the diminished contraction of the diaphragm, the posterior portion of the apex of each lung becomes insufficiently aerated, and disease follows, pulmonary tuberculosis being of not infrequent occurrence. Other maladies result from compression of the stomach and intestines. Restriction of the heart's action may be seen orthodiagraphically. The abdominal and thoracic muscles become flabby and toneless, and disuse of the vertebral muscles and limitation of the spinal movements tend to produce spinal curvature. A properly made and well-fitting corset, however, is open to none of these objections, and, from the æsthetic point of view, much may be said in its favour.





as close as possible to the root of the neck in order to permit of free upward movement of clavicles and scapulæ.

(d) *Waistcoats, Coats and Bodices.*—When fastened too tightly across the chest, these are capable of hampering breathing to a marked extent, although the patient may not realise this fact until attention is drawn to it.

*Obstruction of the Upper Respiratory Tract.*—If the obstruction is unilateral, little harm results, but if, in spite of systematic well-directed efforts to encourage nose breathing, the patient even then is only partially able or completely unable to inspire by this route, other things being equal, there is probably some definite obstruction on both sides of the upper air-passages in the shape of chronic catarrh, adenoids, enlarged tonsils, hypertrophied turbinate bodies, polypi, deviated septum, etc., which should at once receive attention, for any obstruction whatever to the free passage of air through the respiratory tract constitutes a hindrance to the natural respiratory process.

*Dangers of Mouth Breathing.*—Even if we breathe through the nose during the day, many of us sleep with the mouth wide open for the greater part or whole of the night. Snoring is thus produced, although, as you know, since the mouth closes and snoring stops as soon as consciousness returns, any individual, on being accused of the habit, will utter a most indignant protest, the vehemence of the protest being usually directly proportional to the magnitude of the offence. As far as I know, no animal save man sleeps with the mouth open, and since man in his natural state breathes physiologically, this unnatural and dangerous habit of mouth-breathing is apparently associated with conditions of civilisation.

*Importance of Breathing.*—The osseous conformation of the nasal cavities and their lining, the Schneiderian membrane, serve to protect the deeper respiratory tract from foreign and irritating bodies, and to render the cold air inspired warm enough not to injure the delicate pulmonary tissue.

The incoming air, in its passage through the nasal cavities and over the turbinate bodies, is purified and brought to the requisite temperature for the needs of the organism. Closed lips are the best protection against cold air, and the nostrils are the best and safest of all respirators. Dust and micro-organisms arrested in the nostrils during inhalation are swept out by the expiratory tide. The nose is an important avenue of germ entry, as is seen in many of the acute specific infections, notably diphtheria, so that if the nasal cavities are imperfectly ventilated and left to

atrophy from partial or total disuse, danger to the individual and to the community is much increased. If the nasal passages are free in structure and active in function, the mucous membrane lining them will tend to be healthy, and can deal with infective or irritant substances. By the increased lung expansion which results from nose breathing, oxygenation of the blood is aided, the greater effort which is required having the effect of drawing more air into the alveoli, of keeping them distended, and thus of exposing to the inspired air a greater capillary area.

Many instructors of physical exercises are daily teaching their pupils to breathe in through the nose and out through the mouth. This is a grievous error, if only for the two following reasons:—

(1) The pupils subsequently may become confused as to the direction, and breathe in through the mouth and out through the nose. This has happened not infrequently within my own experience.

(2) Under normal conditions the bronchi and alveoli are sterile, but if expiration be practised only through the mouth, particles of dust, organisms, and other foreign substances from without caught on the nasal mucous membranes and hairs of successive deep inspirations through the nose, owing to the absence of any expiratory current, tend to be drawn in still further. In the absence, also, of this outward air blast, paroxysmal attacks of sneezing, which at times may be very numerous and most distressing to the sufferer, are induced owing to Nature's efforts to get rid of the obstructing or irritating particles.

We are told that man had "breathed into his nostrils the breath of life," and in daily life I cannot urge upon you too strongly the vital importance of insisting upon nose breathing first, last, and all the time.

(b) *Pharynx*.—Marked stenosis in this situation is on the whole infrequent. Retropharyngeal abscess, considerable dyspnœa. In all stages of nasal and pharyngeal catarrh deep nasal breathing has a remarkably curative effect.

(c) *Larynx and Trachea*.—Slight grades of narrowing or blocking will produce serious results on account of the smallness of the air channel.

(d.) *Changes in the Thoracic Parietes and Diaphragm.*

(i.) *Abnormalities in the Shape of the Ribs*.—Changes in the shape of the ribs, at times even amounting to considerable deformity, may result from imperfect or improper methods of breathing, and, as will follow from what I have said previously, in de-



fective thoracic respiration, whether upper or lower, usually the diaphragm also is at fault.

(ii.) *Changes in the Inter-Costal Muscles and Diaphragm.*—In inflammatory states of the lung and pleura a myositis of the intercostal muscles and diaphragm frequently occurs owing to lymphatic absorption of toxic products from the lung. Even slight myositis induces an attempt at costal fixation in order to keep the diseased parts quiet, and thus frequently restricts the mobility of the chest, upon which a sufficient intake of air depends. Fixation of the affected side may be reflex early in the disease, but in chronic cases usually occurs as a result of sclerosing myositis.

(e) *Bronchi.*—The subject of foreign bodies in the air-passages has been so well dealt with of late by Mr. R. J. Godlee (5) that I will at once pass on to a great trio of associate respiratory diseases—namely, bronchitis, asthma, and emphysema.

*Bronchitis.*—(i.) *Acute.*—Here the results of obstruction vary widely, according to (1) the size and number of the affected bronchi, (2) the quantity and nature of the contained secretion, (3) the amount of respiratory energy of which the patient is capable. Thus the mechanical effects are always more marked in cases of capillary bronchitis, especially in children and old people, even if the area involved be small, than when the larger tubes are involved, since the bronchioles are very soon occluded by an amount of secretion which in the larger tubes would give rise to but little inconvenience.

In bronchitis the depth and frequency of respiration may vary considerably, from a simple increase of frequency, on the one hand, to a slower and more laboured breathing on the other, with special prolongation of the expiratory phase, and in some cases marked expiratory stridor. This lengthening of expiration is due to the fact that during expiration the contraction of the elastic thorax tends to further contract the already narrowed bronchioles, and thus to render egress of air more difficult, the obstruction being increased if the accessory muscles are called into play.

After the acute febrile stage is over the "complete breath" may be prescribed, followed by various arm movements.

(ii.) *Chronic.*—In this disease, as well as in asthma, emphysema, and pulmonary tuberculosis, at the outset you will find either that the thoracic and abdominal muscles have never properly developed, or have become atrophied to a greater or less extent from disuse. In such cases, before breathing exercises can

be undertaken, we must seek to improve the condition of the muscles by regular and suitable applications of massage and electricity. These methods should be particularly directed to the thoracic and abdominal parietes. If much fat is present massage must be deep, and in cases of pulmonary tuberculosis should be more generalised in order to improve the general nutrition. Into the details of these applications I regret that time does not permit me to enter, and I will merely say that vague directions as to massage are of no use, and that the physician should be able to give clear instructions as to the means to be adopted in order to produce the particular effect which he desires. One further caution may be added which applies to all forms of respiratory disease, and this is that the patient should never do breathing exercises when tired, nor continue them until tired.

*Asthma.*—Asthma, like other nervous affections, requires variable treatment, and if the exciting cause can be discovered a cure can usually be looked for, although not infrequently the results of treatment are disappointing. Taking the treatment of chronic bronchitis, bronchiectasis, and bronchial asthma together, we find that in some cases much may be accomplished by systematic respiratory gymnastics. In cases where the tubes are blocked by the contained secretions, especially when the feeble muscular power of the patient is unable to expel these, manual compression during expiration upon the external surface of the thorax and abdomen, as recommended by Gerhardt, (6) has the following good effect:—

- (a) Lifting of the level of the diaphragm, with consequent lessening of the dilatation of the lung.
- (b) Increase of vital capacity.
- (c) Promotion of expectoration.
- (d) Diminution of the frequency of respiration.

In the asthmatic attack inspiratory inflation gradually overpowers expiratory effort, leaving the patient fixed and breathless. On many occasions, especially in young subject with elastic chests, the greatest relief is obtained by squeezing air out of the lower part of the chest during expiration with the hand, the patient at the same time helping by strong expiratory efforts. I can vouch for the efficacy of this valuable method, and have employed it in numerous cases with gratifying results. The wheezing abates rapidly or disappears, and considerable relief is experienced. In the intervals between the attacks, walking, riding, cycling, and artificial aëro-therapeutics, especially by compressed air, have their uses in suitable cases. Marcet (7) has compared asthma in those who suffer under low barometric pressure to a



sort of mountain sickness, since the higher the asthmatic subjects go the worse they are.

*Emphysema*.—Dr. William Ewart, (8) lecturing recently before the Polyclinic, has shown with much truth that the essence of the pathology of the condition is limitation of the respiratory function of the lung and of the right heart. The elasticity of the lungs is greatly impaired, and the diaphragm is low in position, but hypertrophy of the transversales abdominis prevents ptosis of the viscera. In emphysema there is a slow progressive tendency to over-expansion of the lung, which in a case of long-standing disease implies use of the complemental and of a portion of the tidal supply, with inability to utilise the remainder of the tidal amount or the supplementary expansion. Seeing that there is "a persistent neglect to deflate the lung by deep expiration," the main principle for the prevention and cure of emphysema is to restore the expiratory function, and this can only be done by efficient mobilisation. The operation of costotomy, recently revived, especially by German surgeons, led by Freund, after falling into disuse for many years, should perhaps again be relegated to the obscurity from which it has been withdrawn. Apart from the risk of pneumothorax, the operations appear to have no lasting value in long-standing cases where secondary changes have taken place in cartilages, muscles, and joints, and in the early cases which depend largely upon failure of the abdominal musculature to raise the diaphragm to a high level within the thorax, attention should rather be directed to massage and resistance-movements of the abdomen. When an emphysematous patient begins to notice shortness of breath, he instinctively tries to gain relief by increasing his inspiratory efforts at the expense of expiration, with the result that the condition is thereby aggravated. "There need have been no emphysema had deep breathing been made an early study," (8) and breathing exercises begun early in life when emphysema often begins will restore the necessary balance of opposing forces in a way that will be impossible at a later period. Attention should be concentrated upon the expiratory phase, and massage is of the greatest service in restoring tone to the feeble muscles of the abdomen, the effect being aided, in suitable cases, by continuous elastic pressure. Towards the end of expiration the patient is directed to contract his abdominal muscles as much as he can. The action, at first voluntary, soon becomes automatic. Dyspnœa lessens, and the diminution in size of the enlarged lungs can be demonstrated by percussion.

*Pulmonary Tuberculosis*.—Firstly from the point

of view of prevention. In view of the universal prevalence of this disease, which (with other forms of tuberculosis) annually claims one person in every eight as its victim, nearly one-half of all deaths in the United Kingdom, between the ages of 25 and 35,

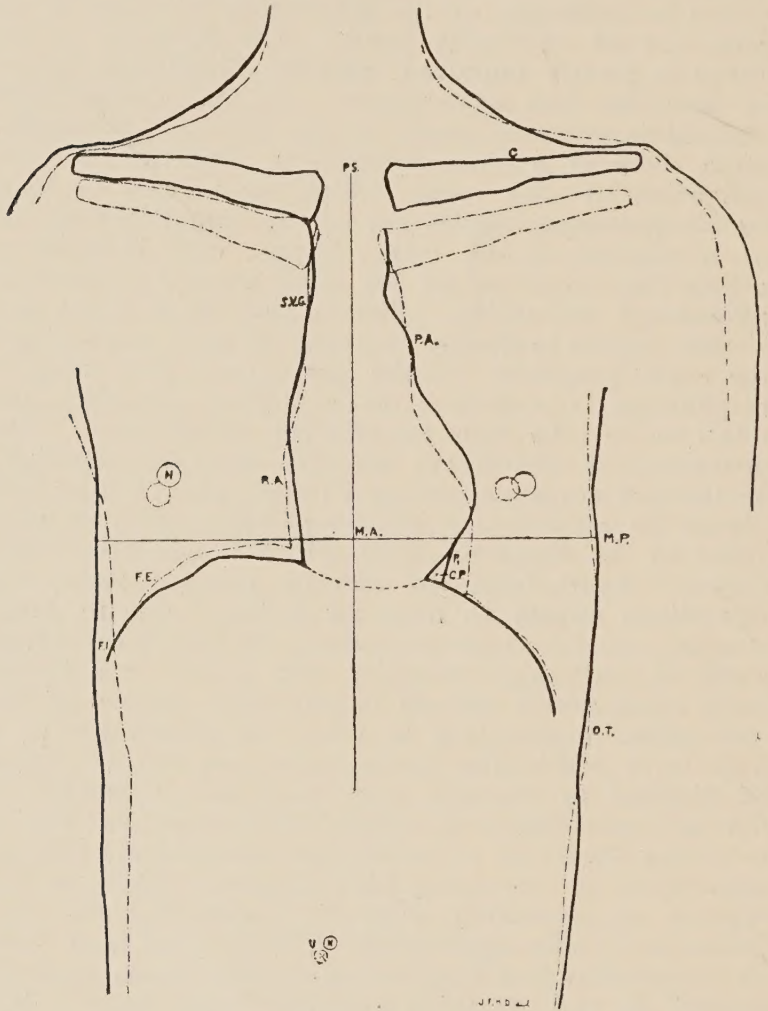


FIG. 8.—ORTHODIAGRAM NO. IV.,

Of male subject, æt. 24, with early active pulmonary tuberculosis of both apices, more marked on left side. The movement of the diaphragm on the more affected side is almost absent. (Compare with Orthodiagram No. I.)

being due to consumption, a method of breathing by which the chest is efficiently expanded in all three diameters is of paramount importance in increasing the resistance of those whose natural or acquired immunity to this disease is but low. In this disease



we have to exercise greater caution than in the others I have mentioned in prescribing exercises on account of the special risks, in particular that of hæmoptysis. My experience is that the greater amount of fresh air the patient gets at any stage of the disease, both by day and night, the better progress he is likely to make, provided that the other conditions are equally favourable. Strong winds should always be avoided. A barrier to infection from the bacillus, even if it obtains temporary footing, is to be found in the vital processes in the lungs.

Orthodiagram No. IV., of the chest of a man, æt. 24, who had active pulmonary tuberculosis of both apices, more marked on the left, shows that on the side where the disease is more advanced the diaphragm is practically motionless, and that there is hardly any lateral costal movement, but slight compensatory upper costal movement is present. On the other side there is considerable limitation of the diaphragmatic movement, with slight corresponding lateral costal, and little upper costal movement.

The movement of the unaffected lung is usually greater than that of the diseased lung. In the latter the lower lobe is less expanded and less lowered, the costal walls expand insufficiently, and the diaphragm does not descend so far, either in quiet or in deep breathing. Up to the present, too little importance has been attached to the vertical movement of the lung, brought about by the diaphragm in inspiration, by which the posterior part of the apex of the lung is expanded. The diaphragm is an important factor, and "unilateral limitation of diaphragmatic movement is often the earliest sign of pulmonary tuberculosis." (3) Hence it is of vital importance that diaphragmatic breathing be specially developed in pulmonary tuberculosis as soon as the disease is in a quiescent state. I believe that this restricted movement, which is capable of orthodiagraphic measurement, is always present in early stages of the disease, but that very often it passes off when arrest or chronicity ensues. As regards treatment, until a specific remedy is found, the injection of tuberculin being a notable step in this direction, our hopes must still be centred on abundance of good food and continuous fresh air. Breathing exercises are to be practised only when the temperature and disease are quiescent. Complete breathing is then instituted, and, if well borne, is succeeded by a series of passive and graduated resistance exercises, the time taken being ten to fifteen minutes, twice daily.

*Passive Congestion of the Lungs.*—This condition may and often does take place at the bases and pos-

terior obtuse margins, by reason of impeded and ineffective breathing, dependent upon the difficulty of expanding the chest backwards, whilst in the recumbent posture, unilateral congestion, caused by lying on one side, is not infrequently noted. Change of position, in combination with breathing exercises, will alter this static condition into one which is dynamic, and the vicious circle will be broken by the renewal of sufficient oxygenation and circulatory return.

*Pneumonia with Delayed Resolution and Pleural Adhesions.*—When it is desired to expand both lungs simultaneously, respiratory gymnastics may be practised by means of blowing-bottles. Where it is desired to expand one lung at a time, the best and simplest method of accomplishing this is to seat your patient sideways on a straight-backed chair, the seat of which is sufficiently low for him to be able to plant his feet firmly on the floor. He then puts his arm over the back of the chair, resting his axilla on the top of it after the fashion of a crutch, whilst at the same time he grips the seat. Then, sitting straight up, with one side pressed firmly against the chair-back, so as to compress the chest, by a series of deep breaths he can produce much greater inflation of the other lung than is possible without immobilising the opposite side.

To ensure maximum oxygenation of the blood, and to improve the circulatory and alimentary processes, to relieve the congested lungs of mucus, and to make expectoration easier, there is no better method, in my experience, than careful and systematic breathing exercises, under the personal direction of a skilled physician.

I should like to deal with malnutrition and anæmia, with the promotion of absorption of inflammatory exudates in general, with heart disease, stammering, and obesity. Each of these maladies has its own special place in an ordered system of respiratory therapeutics, but too long already have I trespassed on your consideration.

Gentlemen, in the foregoing remarks I have tried to place before you, to the best of my ability, some of the recent views which are held with reference to the mechanism of respiration in health and disease. If from lack of time I seem to have omitted that which some may think worthy of inclusion, or to have dealt but superficially with some portion of this subject in which one or other is interested, I trust that I may be pardoned. Within the limits of this lecture it has been out of the question for me to do more than touch upon the fringe of this great and increasingly-absorbing subject.



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